BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

Intermediate Tracker R&D and Prototyping

Rachid Nouicer
For the Intermediate Silicon Tracker Group

1. Groups, Production Capability and Assembly Facilities
2. Concepts of Int. Si. Module, Ladder and Barrel
3. S1 Silicon Module Prototype: two HDIs+FPHX Chips+Sensor
   - S1 is the first concept attempted and it is consider an excellent R&D for S0
   - Status, Assembly and Concerns: What Have We Learned?
4. S0 Silicon Module Prototype for INTT: One HDI+Chips+sensor
   - Status and Plan
5. Conclusion and Outlook.

Intermediate Tracker (INTT) R&D Program

The Intermediate Tracker is heavily based on the PHENIX FVTX technology:

	FVTX	Intermediate Silicon Tracker
Sensor	Strip sensor (320 um) - Trapezoid shape	Strip sensor (320 um) - Rectangular shape
Chip	FPHX	FPHX (6K chips left over from FVTX)
HDI High-Density Interconnect	Trapezoid shape (power, bias voltage, slow control…)	Rectangular shape - concept based on FVTX HDI
Extender Bus	Connect HDI to ROC	FVTX HDI but longer
ROC board	- based on the rad-tolerant ACTEL ProAsic3E FPGAs - Trapezoid shape	Re-use FVTX ROC

Intermediate Tracker uses very conservative technology (low risk)

Groups Working on The Intermediate Tracker

J-Parc
- S. Hasegawa
- H. Sako

LANL
- M. Brooks
- M. Liu

Brookhaven National Laboratory
- J. Huang,
- M. Lenz,
- E. Mannel,
- R. Nouicer,
- R. Pisani

Inner Silicon Tracker well surrounded by experts

RBRC
- T. Hachiya,
- G. Mitsuka,
- Y. Yamaguchi

Rikkyo
- H. Masuda

RIKEN
- Y. Akiba,
- I. Nakagawa

Nara Woman's University
- M. Shimomura

Names:
Black: participant
Blue: consultant
Green: support

Production Capability and Assembly Facilities

Electronics Support Lab.

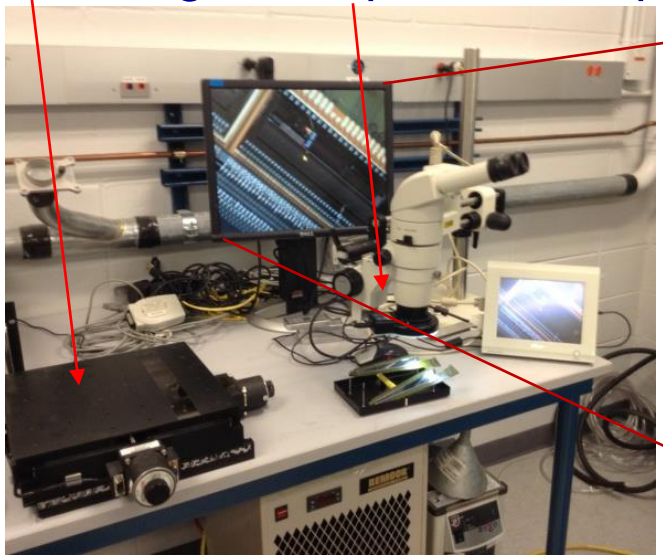
Machine Shop

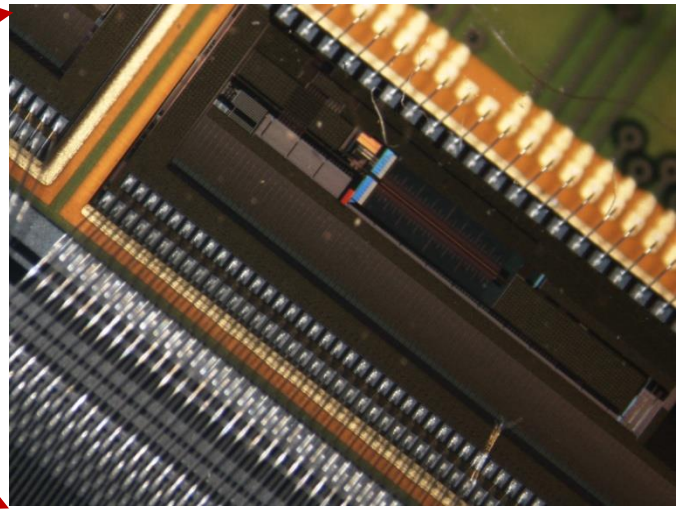
Detector support lab

Main Silicon Lab

Production Capability and Assembly Facilities

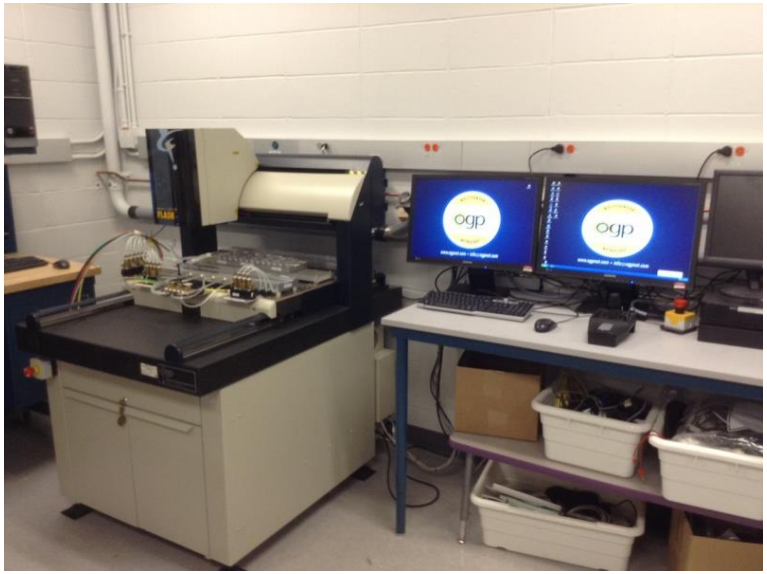
XY Stage Inspection scope





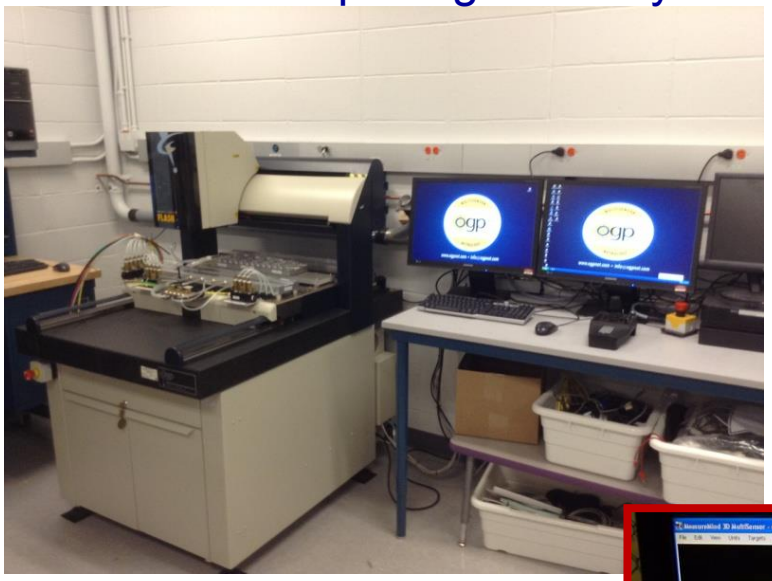
Automatic Sensor Probe Station

OGP Smart Scope alignment system

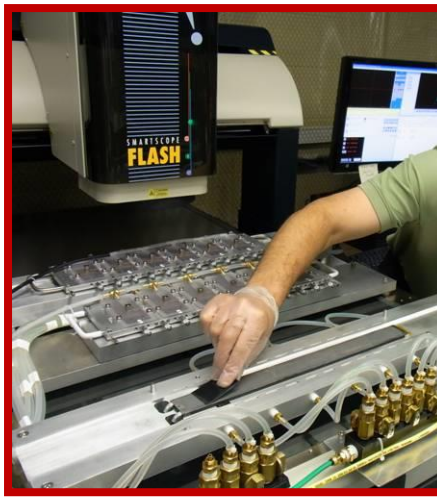


Production Capability and Assembly Facilities

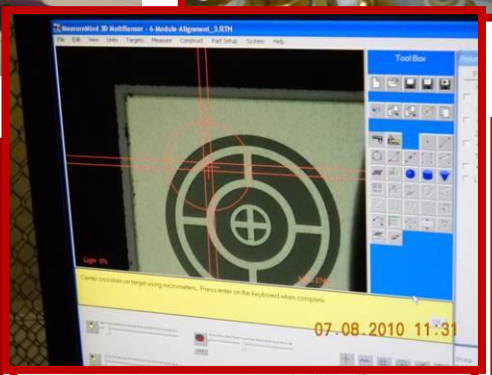
OGP Smart Scope alignment system



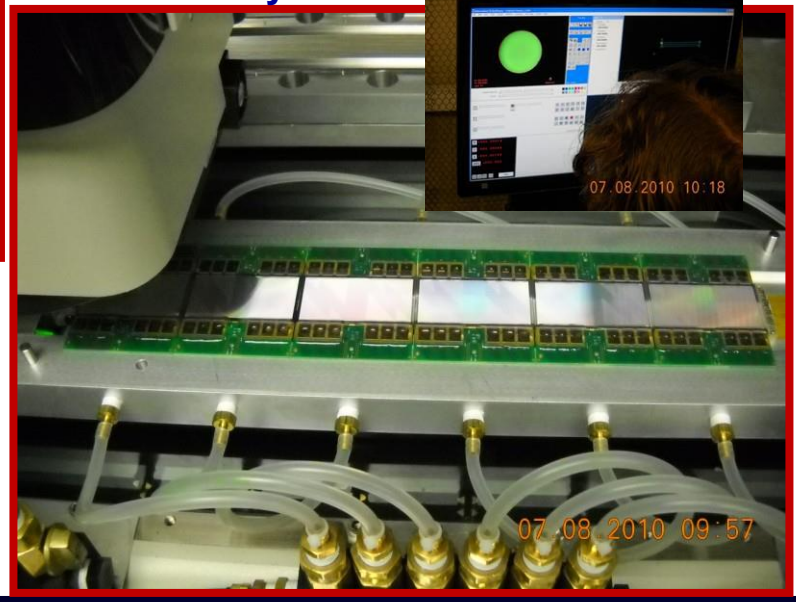
Laser scan of the stave (flatness)



Modules alignment



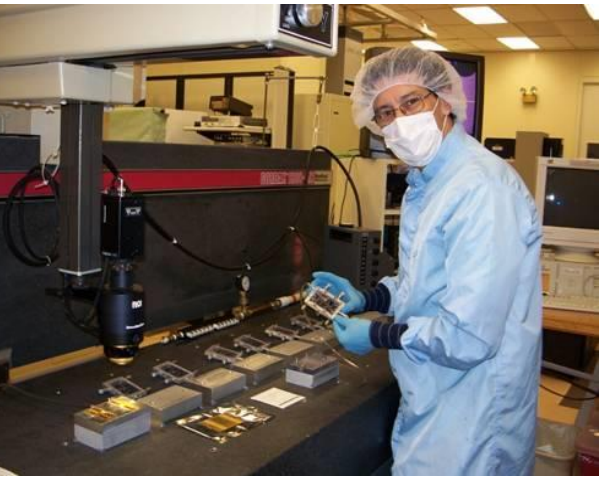
Ladder survey



Measure the reference point of the stave

Capability at FNAL (VTX, FVTX activities at FNAL)

CMM Machine



Wire-bonding Machine

Encapsulation Machine

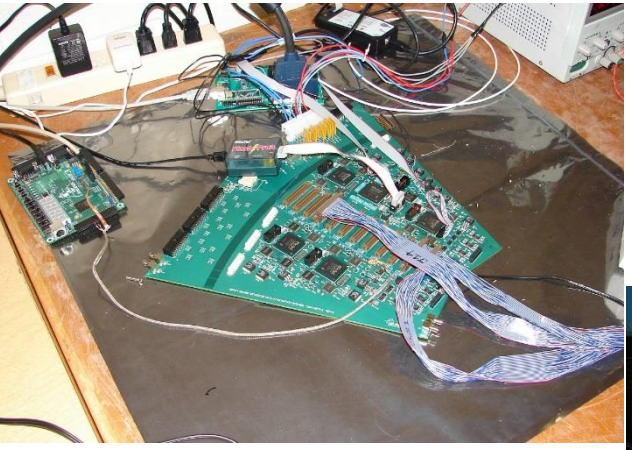
Full Support from FNAL for the R&D of the Intermediate Silicon Tracker

Manpower Expertise and Availability

Technical Support at BNL

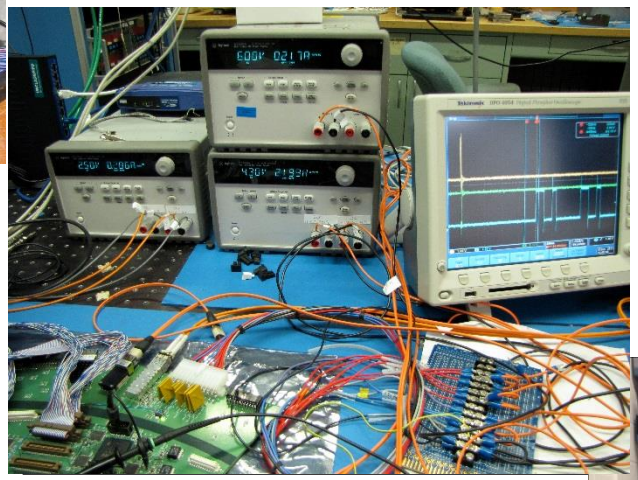
Manpower Expertise and Availability

UNM



FVTX benches' test can be used immediately to test Si Strip modules (use FPHX). They can be used to test prototype of intermediate Tracker module/ladder.

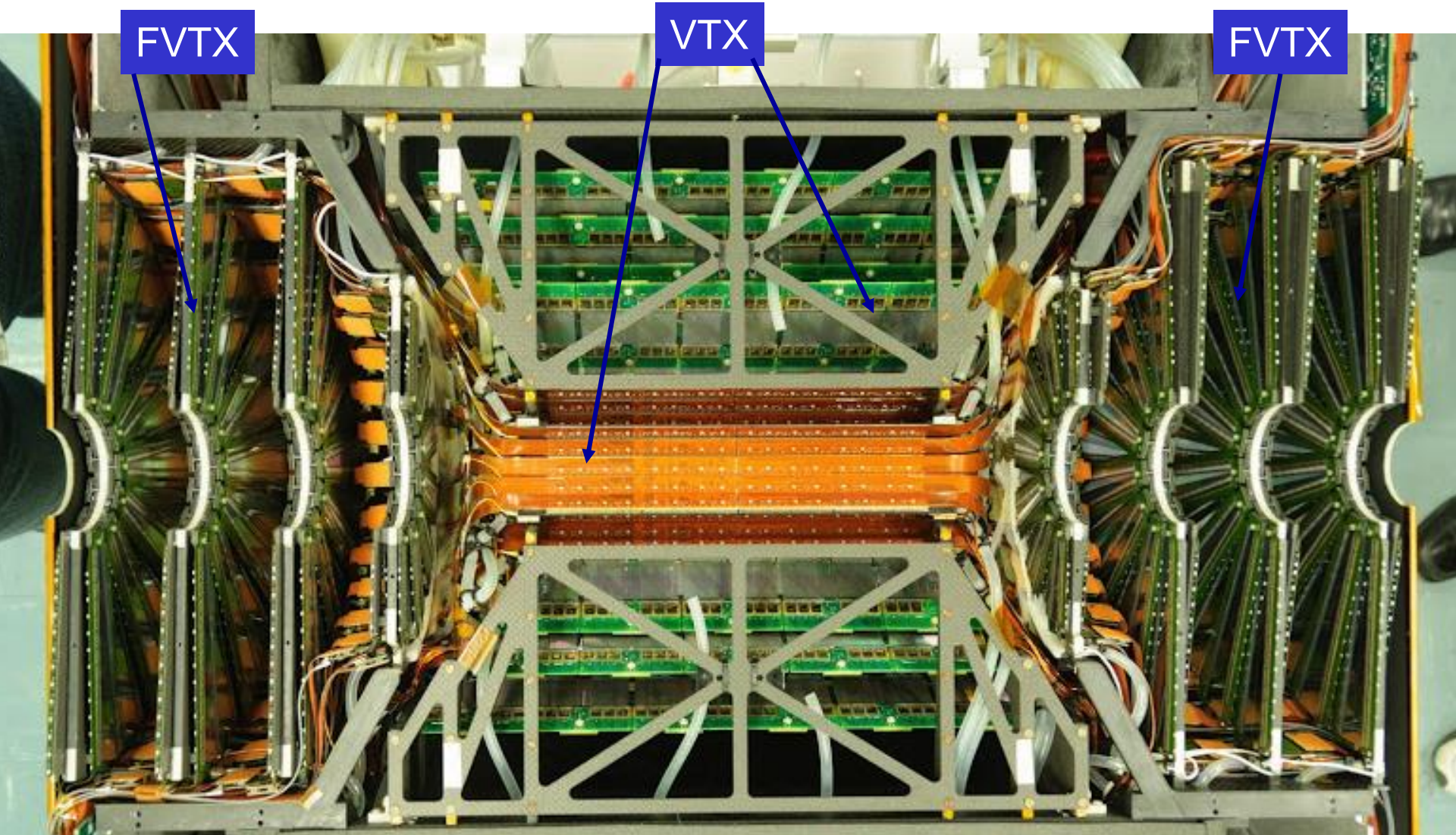
LANL



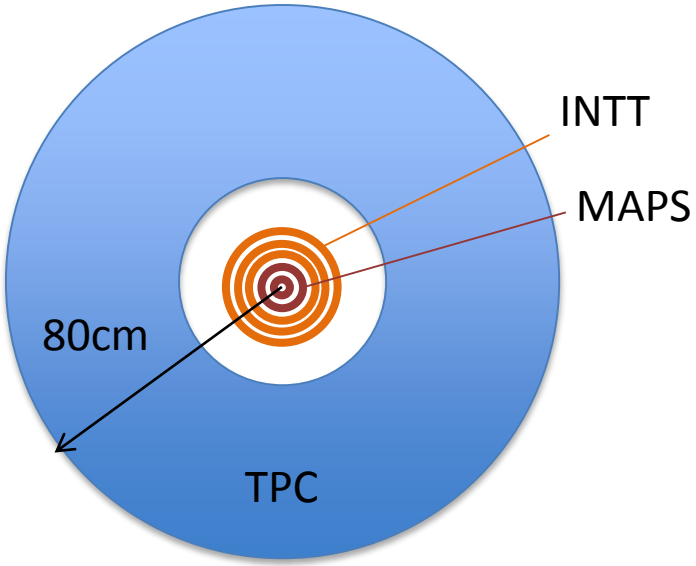
BNL

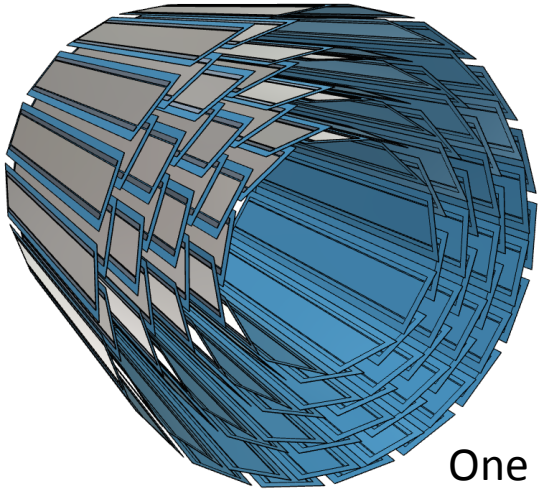
Manpower Expertise and Availability

Tremendous expertise from Si det. (VTX, FVTX) construction:
→ excellent start to boost Si Strip construction successfully



Intermediate Silicon Tracker for sPHENIX





	R [cm]	# of Ladders
MAPS	2.3	
	3.1	
	3.9	
INTT	6	18
	8	24
	10	30
	12	36
TPC	30 ~ 80	

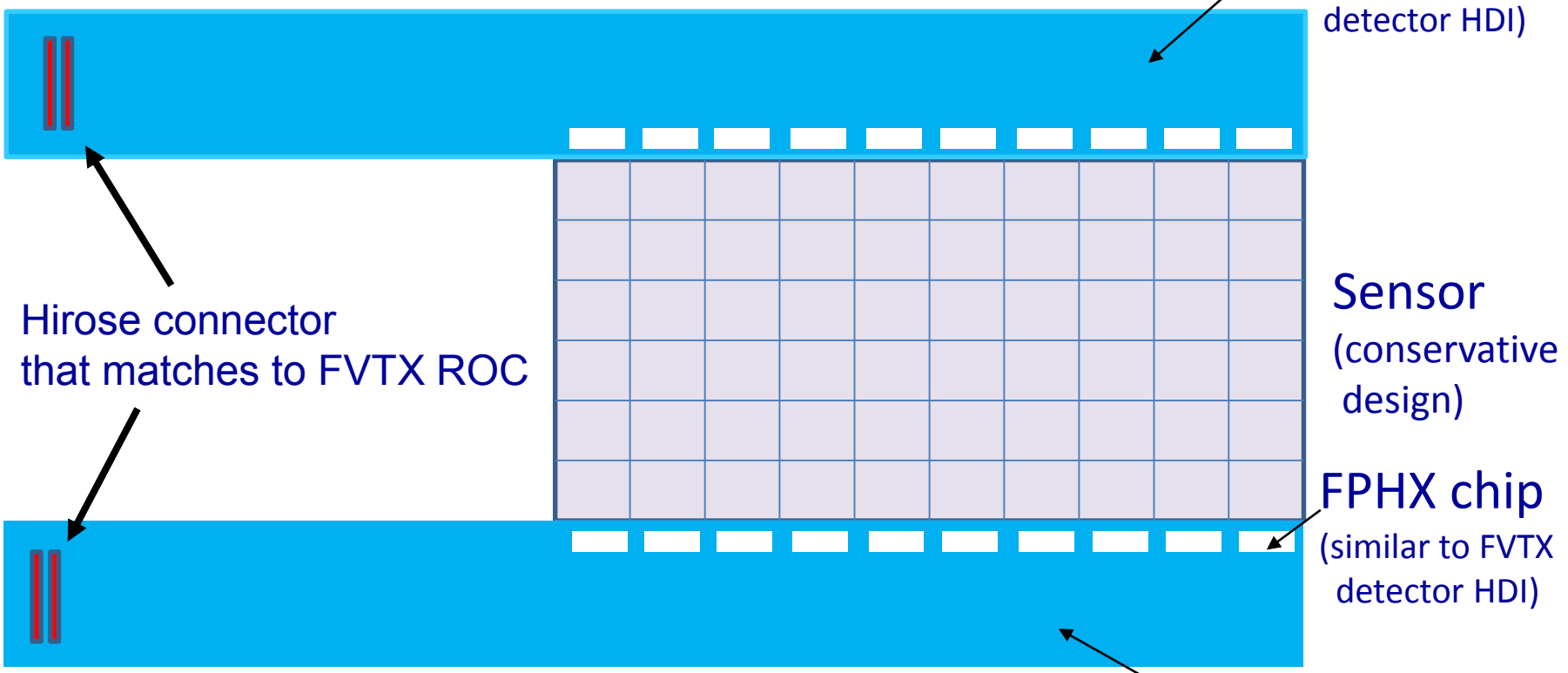
Total Number of Ladders=108

One ladder = two HDIs + two sensors + chips = Two half ladders

S1 Silicon Module Prototype: HDI/Chips/Sensor

- Status, Assembly and Concerns: What have we learned?

Last year, we had a concept of silicon module S1:



- HDI width: 20 mm
- HDI length: 40 cm including the bus part
- Radiation length: 0.28% (physical thickness 0.45mm)
- Electrically the same as the small Wedge HDI of FVTX. This allows read-out via FVTX ROC+FEM

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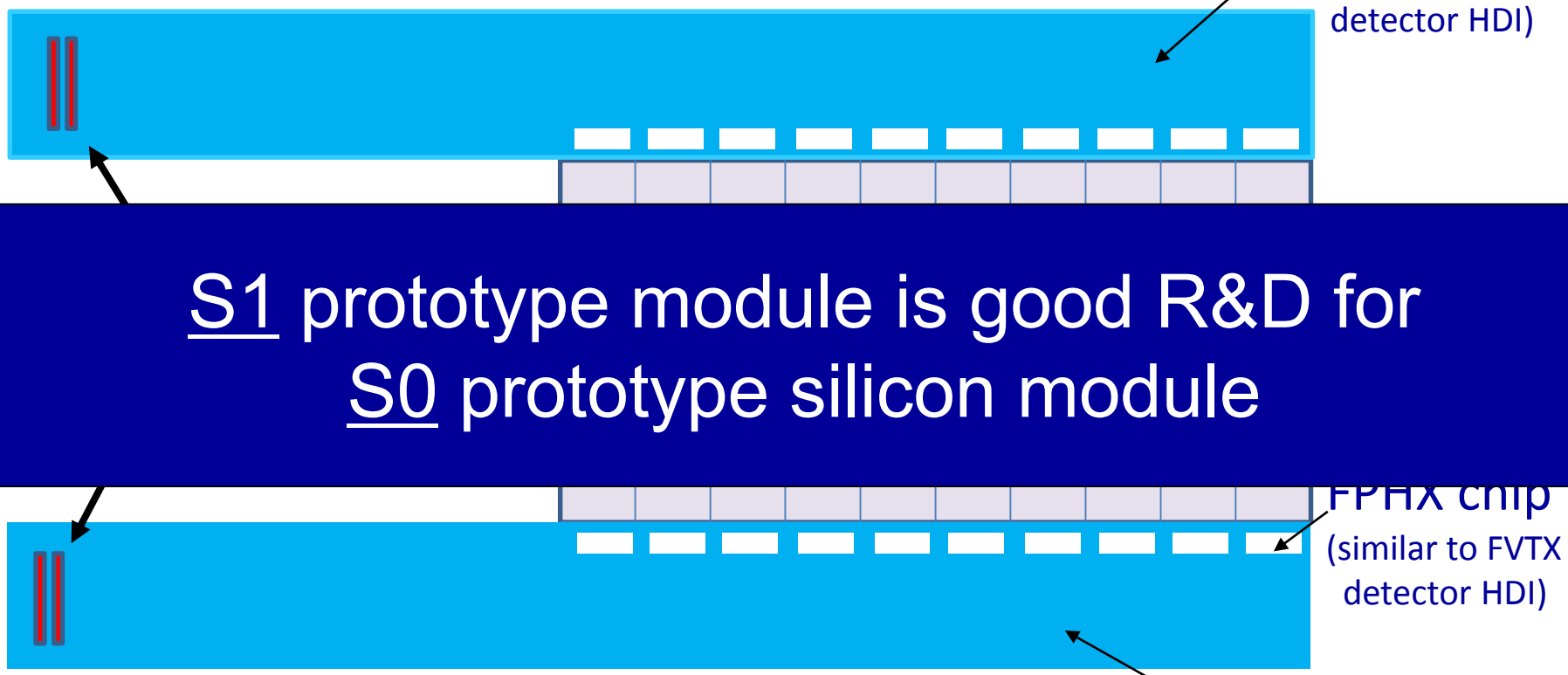


S1 prototype module is good R&D for S0 prototype silicon module

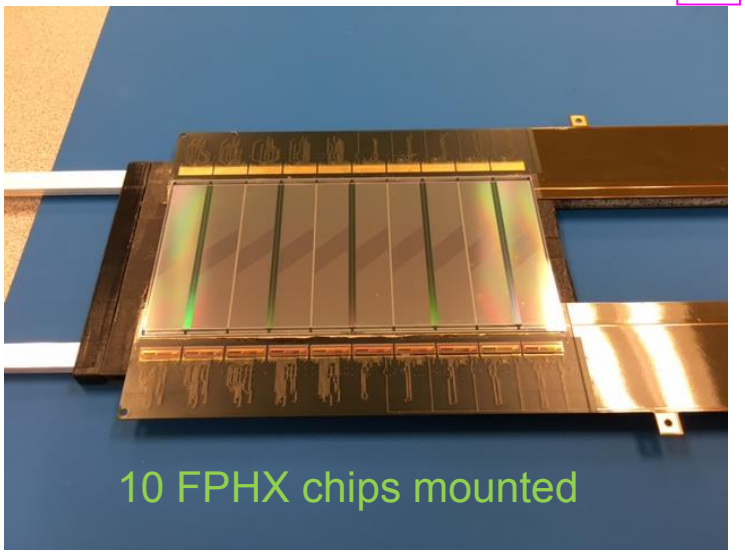
- HDI width: 20 mm
- HDI length: 40 cm including the bus part
- Radiation length: 0.28% (physical thickness 0.45mm)
- Electrically the same as the small Wedge HDI of FVTX. This allows read-out via FVTX ROC+FEM

S1 Silicon Module Prototype: HDI/Chips/Sensor

- Status, Assembly and Concerns: What have we learned?
  - S1 prototype #1 (checking mechanical assembly): bad sensor + bad chips + bad HDI (but all reals)

1

2



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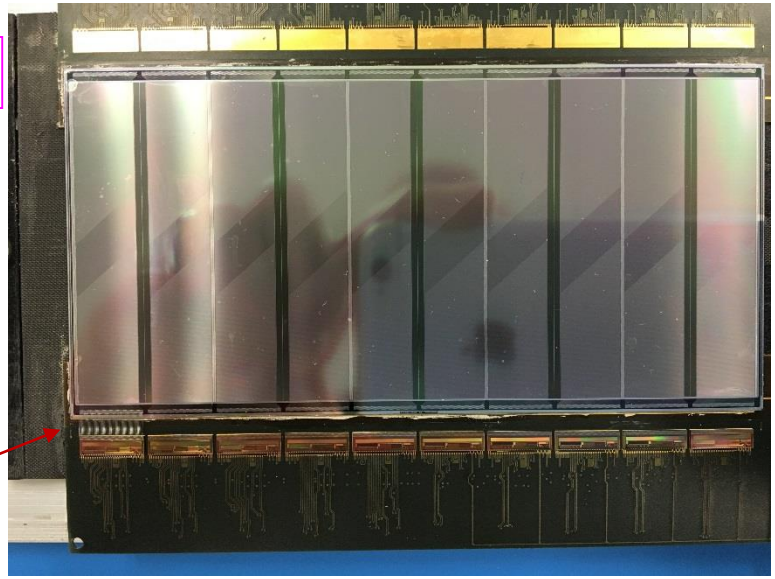
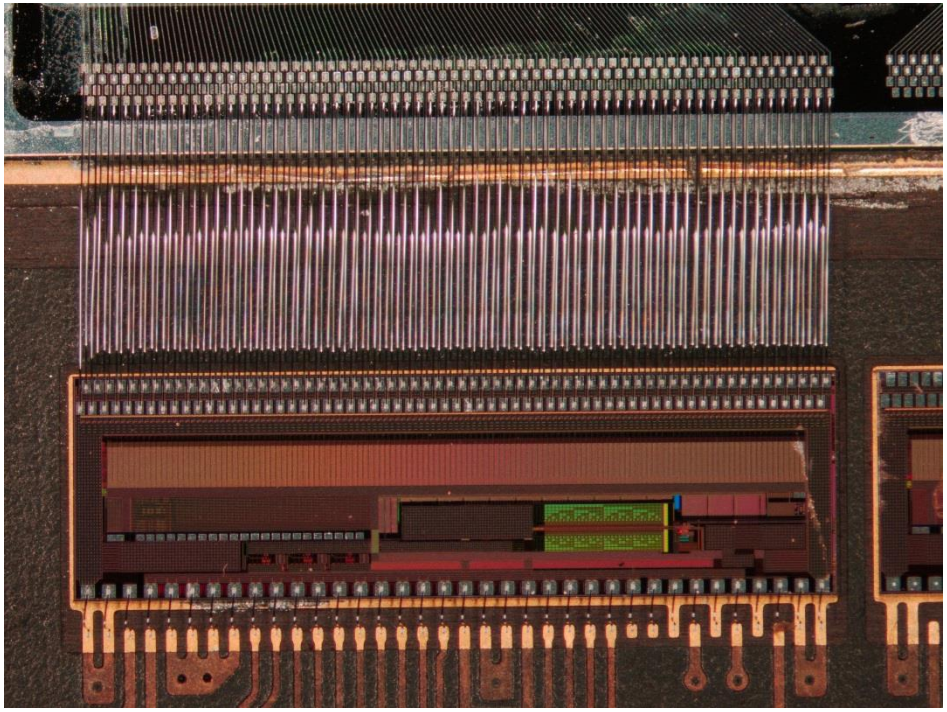


Wire bonded

Silicon Module Prototype S1: HDI/Chips/Sensor

- Status, Assembly and Concerns: What have we learned?
  - S1 prototype #1 (checking mechanical assembly):
    bad sensor + bad chips + bad HDI (but all reals)



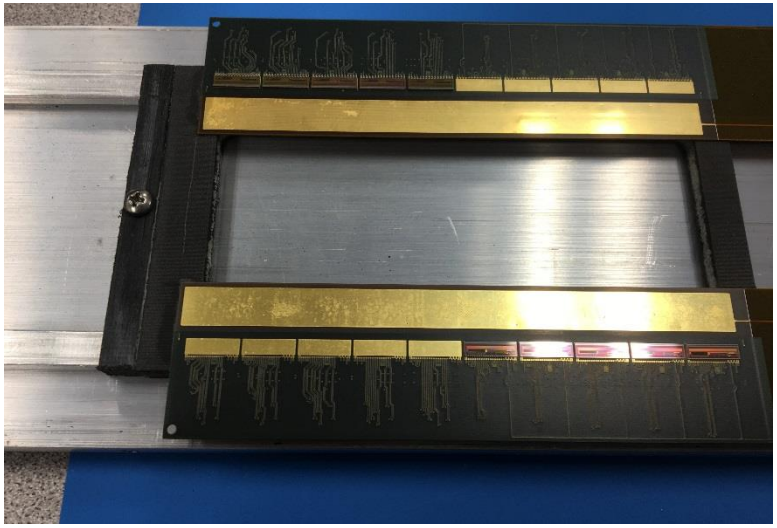
Wire-bondig of the FPHX chip was done at Inst. Div. BNL

- What have we learned?
  - Distance between sensor and FPHX chip is too big (2.5 mm!). It should be reduced to 1 mm.
  - FPHX chip to HDI: move back HDI mask by 450 um
  - Analog ground too small for wire bonding, surface should be increased by a factor 4
  - Glue on some bonding pads on the HDI (bad for wire bonding).
  - We need cross/marker in each corner of the sensor (for alignment

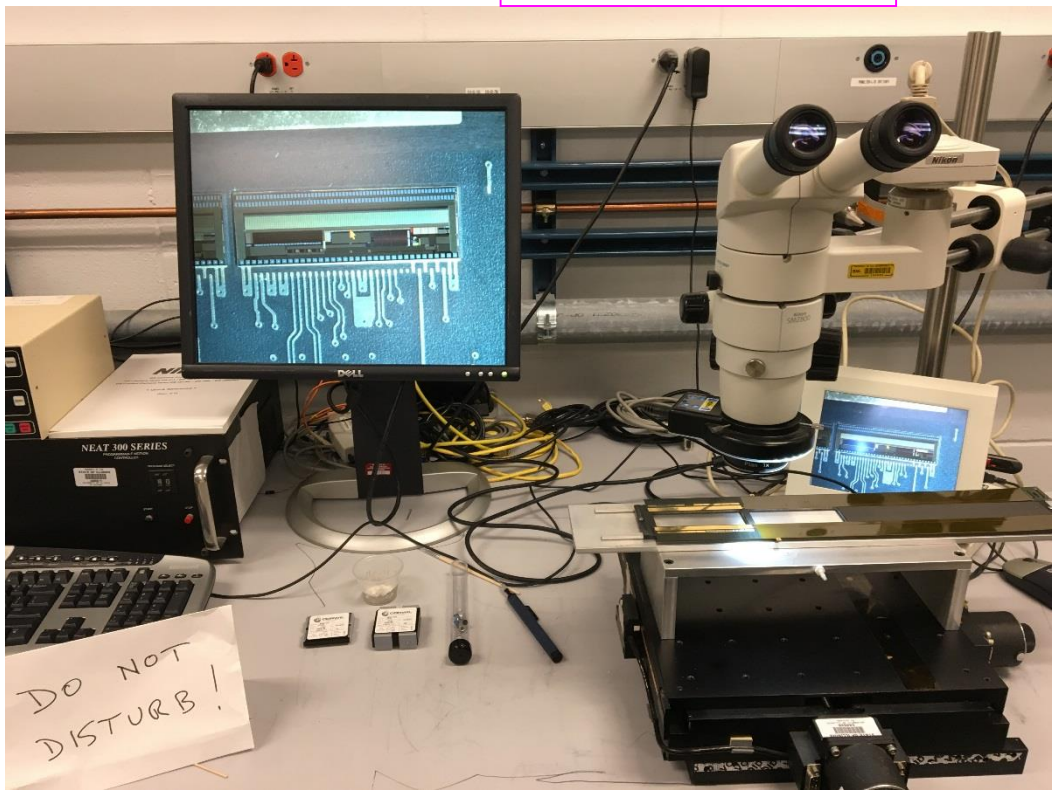
All these inputs were sent to the companies before the production of the new HDI and S0 sensor.

Silicon Module Prototype S1: HDI/Chips/Sensor

- Status, Assembly and Concerns: What have we learned?
- S1 prototype #2 (looking for signal from sensor/chip/HDI): Good Sensor + Good FPHX Chips + Good HDIs

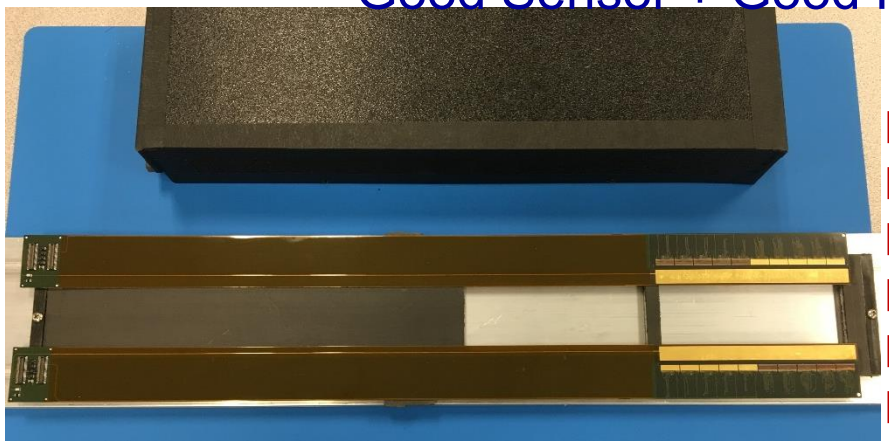


Assembled at BNL

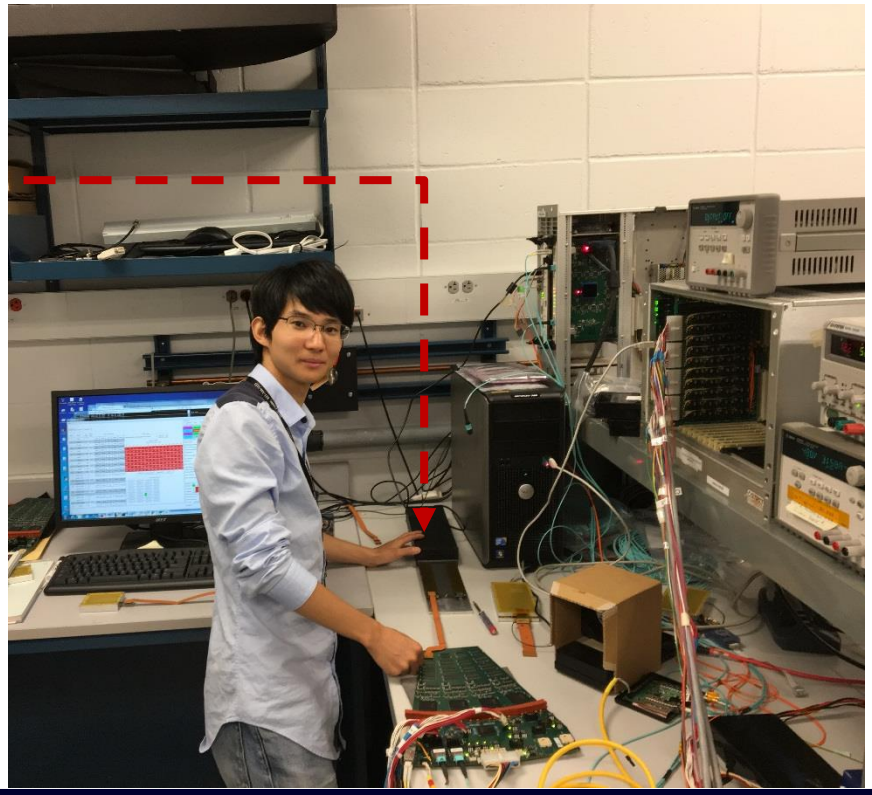


Silicon Module Prototype S1: HDI/Chips/Sensor

- Status, Assembly and Concerns: What have we learned?
- S1 prototype #2 (looking for signal from sensor/chip/HDI):
  Good Sensor + Good FPHX Chips + Good HDIs



Testing bench at BNL
Student: Masuda Hidekazu

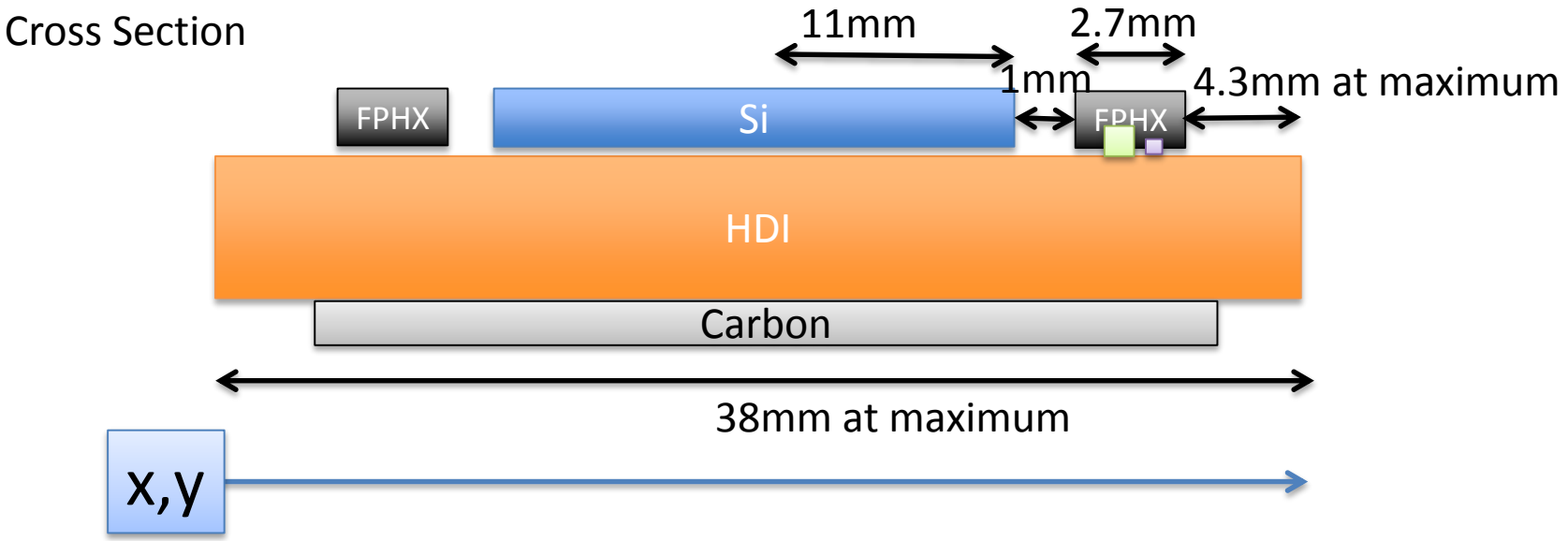


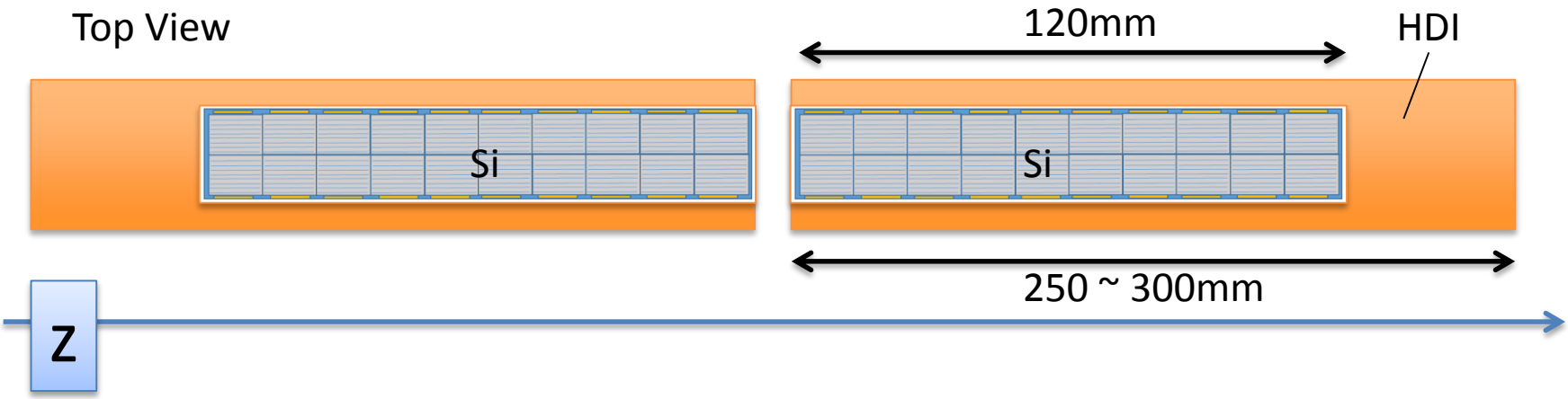
Goals:

1- Check if HDIs and 10 FPHX chips work properly: looking for good signals
2- if (1) is successful, we will mount good sensor/wired and test again.
3- If we get good signal from S1 silicon module prototype: this will be a very good progress toward S0 module prototype .
4- INTT design is a "minimum model" and so we can extend the INTT ladder length with limited risk.

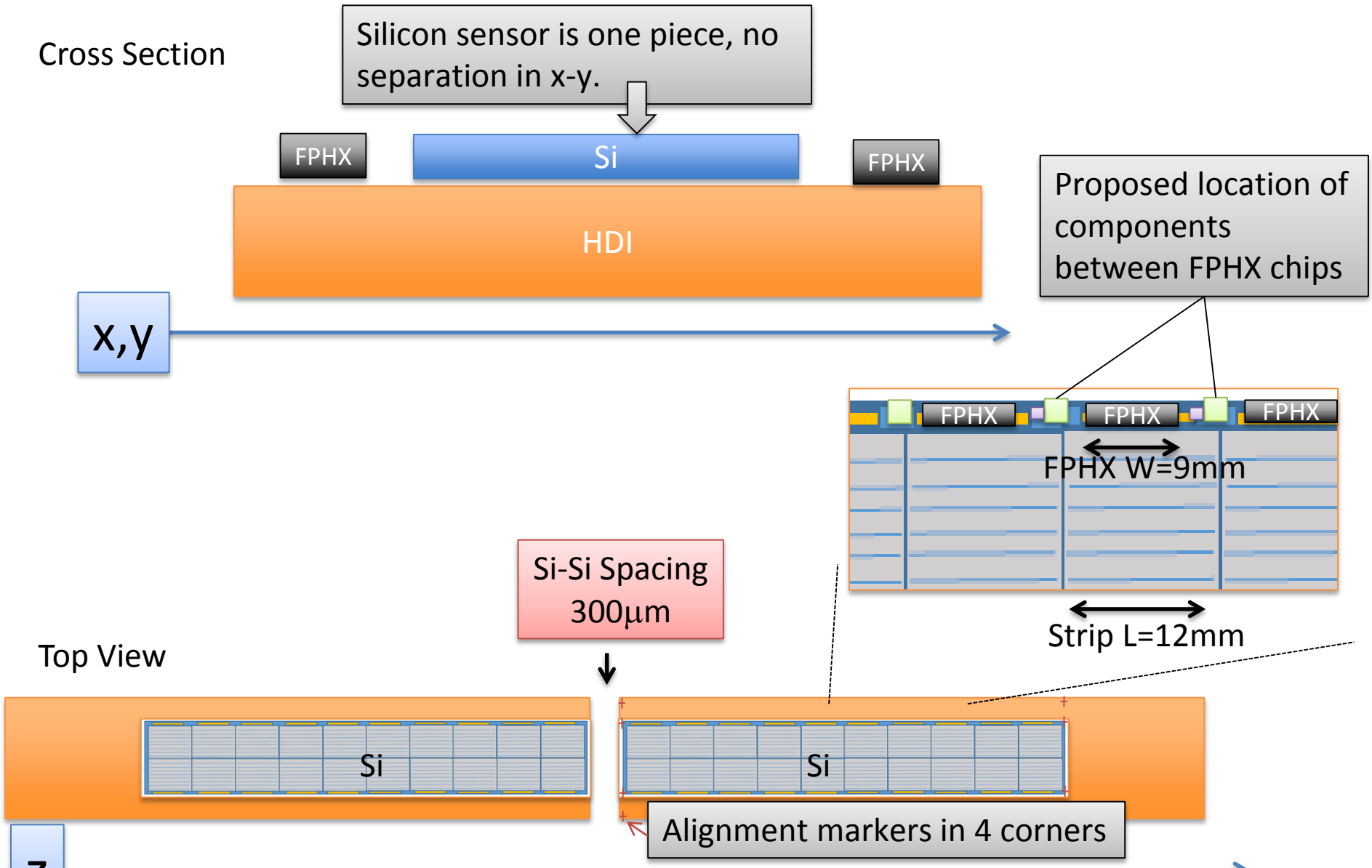
Schematic of S0

- All we have learned from S1 prototype module have been feedback to the companies before production of prototype HDI and sensor for S0 silicon module

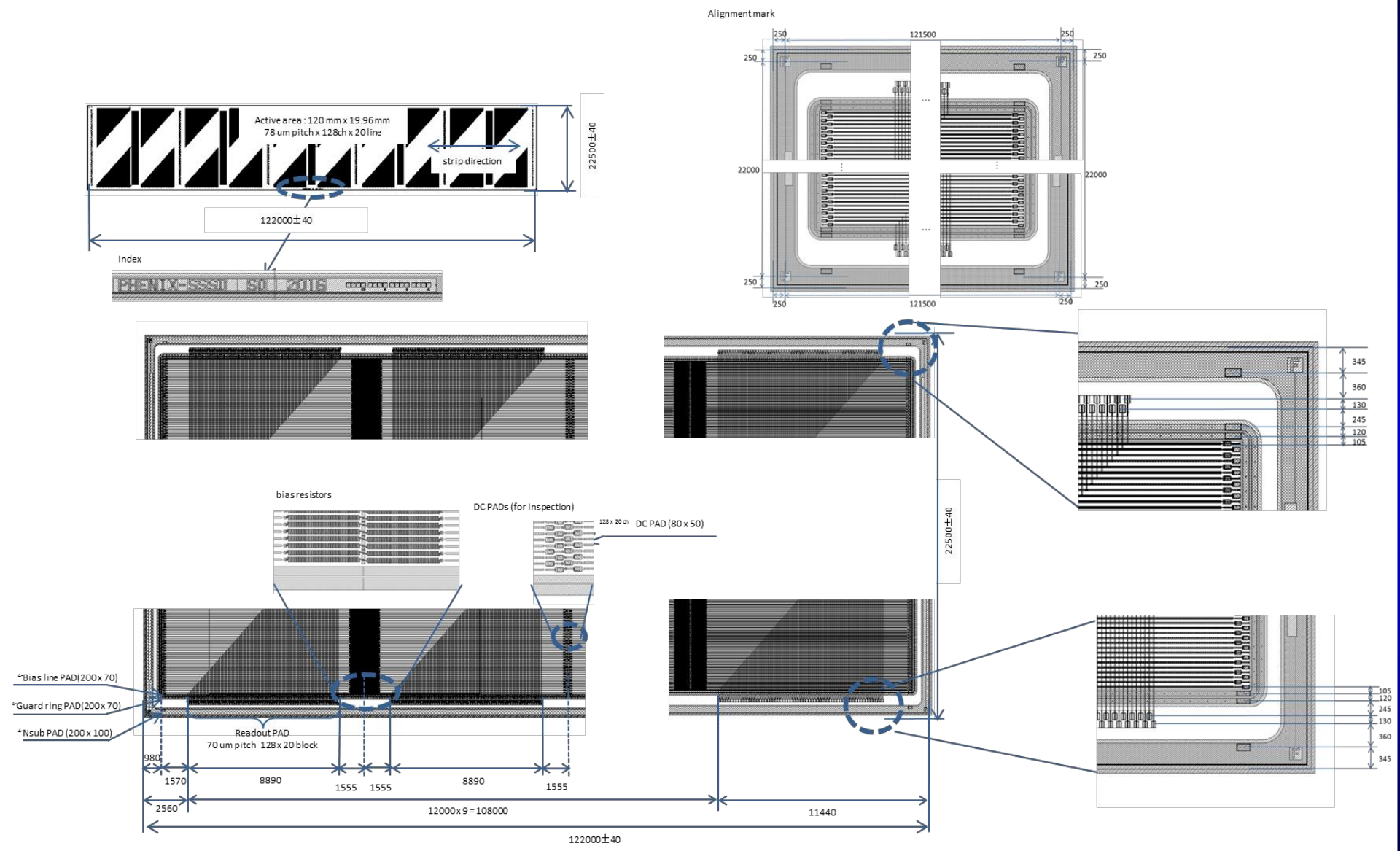




Schematic of S0



S0 Sensor Prototype will Move to Production Soon



Conclusion and Outlook

- Intermediate Tracker has a conservative design. It is based on existing FVTX technology (low risk and low cost).

- Mechanical assembly of S1 prototype silicon module was very successful: Stave + HDI + FPHX Chips + S1 sensor
- Issues and concerns learned from S1 prototype module were sent to the companies Yamashita (HDI) and HPK (sensor)

- S1 silicon module prototype testing is in progress.

- HDI design and silicon sensor design for S0 silicon module prototype are in good progress and under control. Excellent communication with private companies (HPK and Yamashita).

- We have facilities, equipment, and expertise to successfully carry out the Intermediate Tracker project.